Screencasts and Videos in Science Education

Michael Seery*

School of Chemical and Pharmaceutical Sciences, Dublin Institute of Technology, Dublin 8, Ireland.

Overview

This article discusses screencasts and videos in education, with examples relevant to science education. After summarising some principles of good practice, several areas are discussed: (1) development of lecture preparation videos incorporating interactivity; (2) developing videos for flipped lectures; (3) using screencasts for worked examples; (4) using videos for laboratory preparation. Different methods of creating screencasts (Articulate, Camtasia, Tablet PC, video camera) are outlined. [*Presented to the DIT College of Sciences and Health Teaching & Learning session, Dec 2013*]

1. Introduction

Screencasts—a capture of what is on a computer screen—and videos are now very easy to produce, and are becoming ubiquitous in STEM education as teachers and lecturers aim to explain complex concepts through the use of dynamic materials. Students appear to expect some form of electronic learning resource on any topic at hand. The combination of ease of production and student expectation is a dangerous mix in the hands of an enthusiastic lecturer.

As a caretaker to several hundred megabytes of resources now gathering electronic dust, I have learned the hard way to always question whether a resource I plan to make will actually be a useful learning activity in the curriculum as I plan to deliver it. Perhaps an easier way to address this question is to consider what the purpose of the resource is. Generally, they fall into three categories (McGarr, 2009):

(i) A **substitutional resource**: this is something that you will give students in any case, but this is an electronic version. A typical example is a lecture which you deliver, but which is also captured electronically for students to review.

(ii) A **supplemental resource**: this is something that provides additional information to what you personally deliver to students. A typical example would be some worked out questions that relate to what was talked about in a lecture.

(iii) **Student specific resources**: these are often individual to students, for example student generated resources, or feedback on assignments.

All three resources have educational value, and each have advantages and disadvantages. But it is clear that effort spent on substitutional resources is essentially duplicating what you have already done in reality. These resources are popular with students, who like the option of rewatching entire lectures available to them. In reality, most reports suggest that students simply skip to a point of difficulty in the lecture. In fact a recent article suggests that there was a negative correlation between students rewatching lecture capture and exam performance – these students were essentially repeating what was a passive experience (watching a lecture) and not actively working on their understanding of the topic at hand (Revell, 2014). Thus it is ***supplemental resources*** where I argue that most potential lies. These offer potential to elaborate on topics discussed in class, work through problems, and explain the context of a particular topic in more detail.

Other ways of categorising videos are outlined by Kay in her recent review (Kay, 2012). They essentially amount to the same thing. For example, consideration from a pedagogical context, they can be viewed as "receptive viewing", "problem solving", or "student generated". When viewed from the point of view of academic focus, they can be "practical" or "conceptual", a point which will be discussed in the example of laboratory videos.

2. Some design principles

Cognitive load theory describes how learners perceive and interpret new information. This describes the cognitive load, or working memory capacity of a learner. This working memory is limited, and can only process a finite amount of information. The working memory capacity is spread across three types of load: the inherent difficulty of the material (intrinsic load); the difficulty in extracting the information from the learning materials (extraneous load); and the

E: michael.seery@dit.ie P: (353 1) 402 4758 W: www.michaelseery.com/

process of learning and integrating into the long term memory. Therefore, learning materials that have a large amount of content that is unfamiliar to learners, and where it is difficult for learners to extract the structure and salient points of the concept at hand will become overloaded, and there will be little or no room for learning. In these situations, learners tend to resort to surface learning.

In the context of multimedia materials, there are some design principles that have been derived from cognitive load theory (Clarke and Mayer, 2008). Since learners process information through audio and visual channels, both channels should be utilised, for example by showing diagrams and key features (visual channel) but using voiceover to deliver explanatory text (audio channel). Audio should be coincident with accompanying visual material, and recent work by Sweller, the architect of cognitive load theory, demonstrates that segmenting the information can help learners process information – for example by including user driven progress of animations or by sectioning large amounts of material into several smaller units (Wong et al, 2012).

3. Examples from practice

There follows several examples from my own practice. These aim to cover several aspects of using screencasts.

3.1 Pre-Lecture Activities

From the point of view of cognitive load theory, science based lectures are very demanding on novice learners, as they often involve a lot of new terminology, complex relationships and symbols. Therefore the rationale for introducing pre-lecture activities is that by presenting some information in advance, the in-lecture load is reduced as students will have had some time to process the advance information. A full description of the rationale and concept of pre-lecture resources is available elsewhere (Seery 2012).

This strategy is used with first year chemistry students at DIT. In a study aimed at reducing in-lecture cognitive load, pre-lecture screencasts were used to introduce the core topic of each lecture. These activities take about 5 minutes to watch, and whatever extra time needed for the students to complete a simple quiz. Typically students spent less than 20 minutes completing the activity. The quiz links directly to the *webcourses* gradebook (virtual learning environment) through a SCORM interface, meaning that little on-going work is required of the lecturer once the system is set up.

A screenshot from one of the pre-lecture activities is shown (Figure 1). Cognisant of multimedia design principles, the amount of visual information on the slide is kept to a minimum, showing key features of the topic under consideration. An audio voiceover plays in the background.

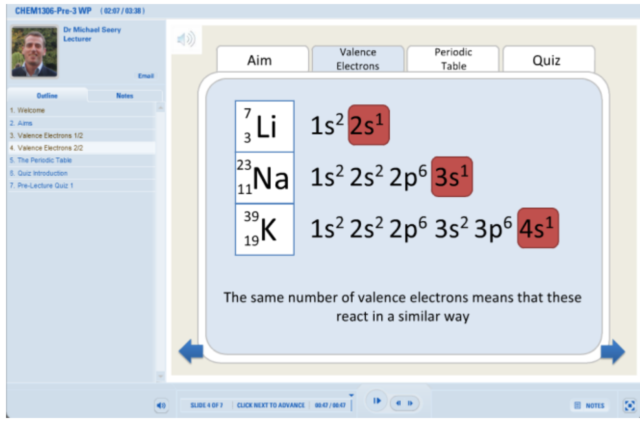

Figure 1: A pre-lecture activity screencast prepared using Articulate.

These activities were prepared using Articulate software (www.articulate.com). These allow for highly interactive screencasts to be made, where users can control the pace of the presentation, interact by selecting choices, completing quizzes etc. The downside is that they are Flash-based resources, so don't work on Apple iPads or iPhones, and there were some problems with playing the screencasts on library computers. The latest version of Articulate produces HTML5-based resources which can play on any device.

The implementation of pre-lecture activities in first year was initially brought about to reduce a performance gap in year 1 semester tests and end of year exams in chemistry. It had been found that students who had no chemistry from school significantly under-performed in first year in college when compared to those who had. In the years since the implementation of these resources, this gap has disappeared (Figure 2). Students also like the resource, as they get some feedback on their understanding of a topic each time they complete a resource. Full details of this study are available (Seery and Donnelly, 2012).

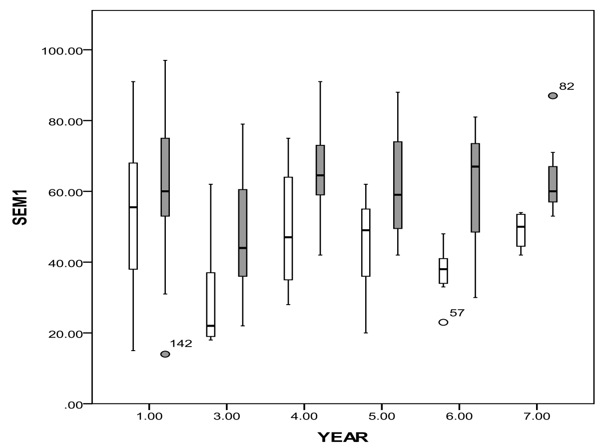

Figure 2: The difference in scores in semester tests between students who had (shaded) and had not (white) chemistry was significantly different in all years prior to the implementation. Difference in year of study (far left) was not significant.

3.2 Flipped Lectures

Having discussed the concept of presenting *some* information in advance, the next step was to move the entire content delivery element of a lecture to before the class. This is known as the “flipped lecture”: the content delivery moves out, and problem solving and discussion moves into the lecture room.

There is a scant literature on flipped lectures, but basing in on the principles of cognitive load theory, there is good reason to investigate. A current study in DIT is examining the use of flipped lectures with Year 2 chemistry students. Screencasts are produced which cover the content of each lecture – these are typically 10 minutes long to cover a major topic. Student handouts are produced, which students print out and use while watching the online lecture. This is important, as it gives them an activity to do while watching the video, and also ensures that they have a structured set of notes. The students complete a quiz after watching the lecture and prior to attending class. These quizzes culminate to be worth the 10% continuous assessment component of the module mark. The quiz questions develop on from the worked examples students were referred to in the textbook or that were shown to them in the video. The entire process is managed through *webcourses*.

In this case, the screencasts (Figure 3) were prepared using Camtasia (www.techsmith.com), screen-casting software that allows annotation of videos, inclusion of chapter of contents, and some basic quizzing. The quizzes in this case were separate to the video, and were built using the Tests function in *webcourses*.

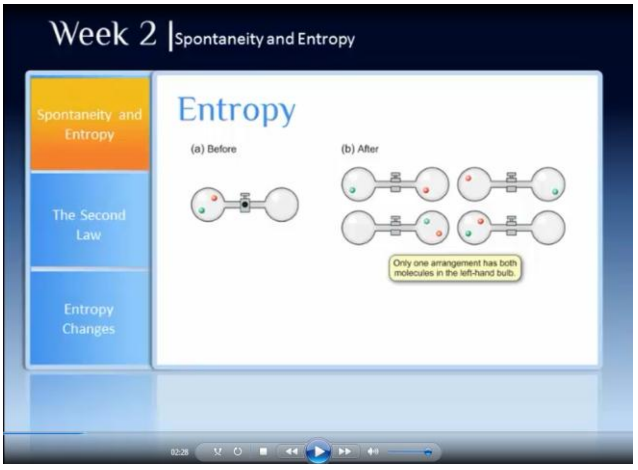

Figure 3: Screencast developed using Camtasia, which records the screen (in this case PowerPoint slides). Image on the slide is from Chemistry[3] (Oxford University Press) and is used with permission.

The evaluation in this case focusses on the engagement, particularly the *cognitive engagement*, with the online material and with the in-class work. This is being measured by a variety of factors – in class attendance (above year average); quiz mark (approximately 69% average); whether students watch the videos (>90% viewing, Figure 4); and in-class engagement. The latter is being measured with a cognitive engagement instrument validated previously (Rotgens and Schmid, 2011).

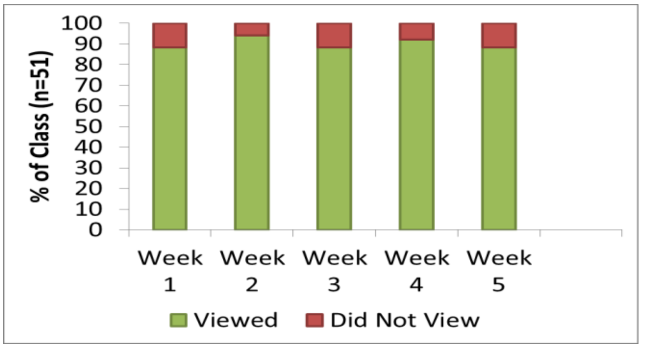

Figure 4: Views of weekly screencasts in flipped lecture study at DIT

3.3 Worked Examples

Worked examples have a good grounding in cognitive load theory (Crippen and Brooks, 2009). When solving algorithmic problems, there is typically a series of steps to complete. The combination of remembering what steps to complete along with the conceptual theory can overwhelm novice learners. Therefore, worked examples aim to show in a series of identified steps, how to approach and solve a problem. Therefore in learning how to solve the problem, the learner approaches it one step at a time. As they work through the problems, the level of assistance provided is reduced, so that with each iteration, students complete one extra step themselves until they can do the entire problem.

At introductory level, there is enormous scope for using worked examples. Their framework involves devising a series of steps, and generating a series of problems where successive steps are removed. Two screenshots of a worked example are shown. Figure 5 is a highly structured worked example, where the steps have been identified in the first phase, with the student watching as each step is completed. In the second phase, the student is presented with each step in turn, and asked to work out the answer to that step. After being given feedback on their answer to each step, the student can identify any particular stage causing difficulty.

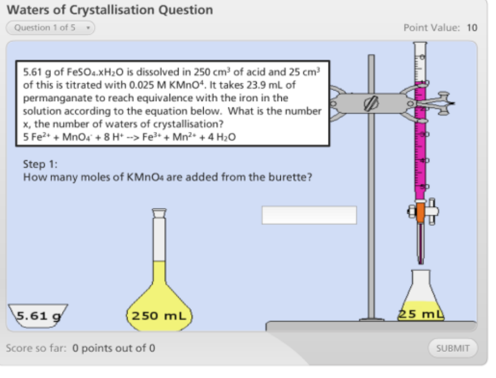

Figure 5: Worked example – allowing students to check understanding at each step.

This interactive screencast is developed using Articulate software. A more straightforward method, probably better for students with some expertise in the topic is to provide demonstrated answers. These can be easily generated using tablet PCs (Figure 6).

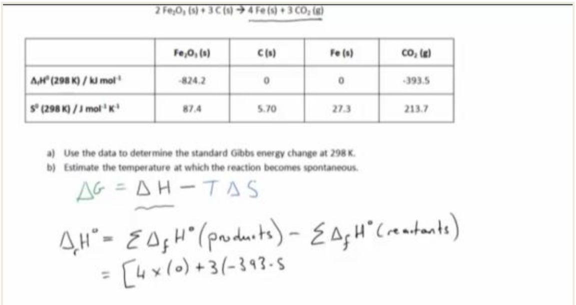

Figure 6: Worked example – a screencast with audio (captured using Camtasia) showing the workings to a question.

3.4 Laboratory Videos

The videos so far have referred to interactive presentations or screencasts. The other alternative is to use video camera to video lectures or laboratory instrumentation. Laboratory videos have great potential to demonstrate how an experiment works, which students can watch as a preparatory exercise. Returning to the earlier classification of "practical" and "conceptual" (Kay, 2012), there is a temptation for pre-laboratory videos to focus on the practical component – showing how to use an instrument. In terms of cognitive load theory, the preparatory work is better focussed on the underlying concepts of a laboratory, leaving the bulk of the practical manipulation to the laboratory class itself, where it can be taught "just in time" " (van Merrienboer, Kirschner and Kester 2003).

Figure 7: A laboratory preparation video. The focus in these videos should be on the underlying concepts rather than details of experimental protocol.

Some initial work on laboratory videos has been trialled in for chemistry students at DIT, especially on topics of difficulty to students. To produce these videos, a video recording is imported into Camtasia, where it can be edited and captions added. One aspect unique to video production is that the background sound in labs is usually quite high, so they usually require over-dubbing after the recording. This audio can be easily added into Camtasia. Other examples are available on the YouTube channel: www.youtube.com/mkseery.

Conclusions

Video offers enormous potential to lecturers wishing to assist students with various topics of their learning. When creating resources, it is worthwhile to be mindful of the purpose of the resource and where it fits in the curriculum, as well as some core principles of multimedia design and a consideration of the pedagogical basis of the intervention.

Acknowledgements

I would like to thank Dr Roisin Donnelly of DIT's Learning Teaching and Technology Centre for her on-going support; Dr Claire Mc Donnell and the Chemistry Education Research Team for working on the various projects mentioned herein. The Royal Society of Chemistry, NDLR, and DIT funded various aspects of this work.

References

Clarke, R.C. and Mayer, R.E. (2008) *E-Learning and the Science of Instruction*, 2nd ed. San Francisco: Pfeiffer (Wiley).

Crippen, K. J. and Brooks, D. W. (2009) Applying cognitive theory to chemistry instruction: the case for worked examples, *Chemistry Education Research and Practice*, 10(1), 35–41.

Kay, R. H. (2012) Exploring the use of video podcasts in education: A comprehensive review of the literature, *Computers in Human Behaviour*, 28, 820-831.

McGarr, O. (2009) A review of podcasting in higher education: Its influence on the traditional lecture, *Australasian Journal of Educational Technology*, 25(3), 309-321.

Revell, K. D. (2014) A Comparison of the Usage of Tablet PC, Lecture Capture, and Online Homework in an Introductory Chemistry Course, *Journal of Chemical Education*, doi: 10.1021/ed400372x

Rotgens, J. I. and Schmidt, H. G., *Advances in Health Science Education*, 2011, 16, 465-479.

Seery, M (2012) Jump-starting lectures, *Education in Chemistry*, 49(5), 22-25.

Seery, M. K. and Donnelly, R. (2012) The implementation of pre-lecture resources to reduce in-class cognitive load: A case study for higher education chemistry, *British Journal of Educational Technology*, 43(4), 667–677.

van Merrienboer, J. J. G., Kirschner, P. A. and Kester, L. (2003) Taking the Load Off a Learner's Mind: Instructional Design for Complex Learning, *Educational Psychologist*, 38(1), 5–13.

Wong, A, Leahy, W., Marcus, N. and Sweller, J. Cognitive Load Theory, the transient information effect and e-learning, *Learning and Instruction*, 2012, 22, 449-475.